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Social Composition, Social Conflict, and Economic Development

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This paper investigates how social composition affects social conflict and economic development when property rights are unenforceable. Groups follow Markovian strategies for consumption and investment and may also spend effort in an resource appropriation contest. It is shown that conflict prevents investment and growth in a society of symmetric groups. In a society at peace economic growth may occur. Growth, however, is decreasing in the degree of social fractionalization and smaller than it could be under secure property rights. In an economy populated by social groups of unequal size an asymmetric equilibrium exists. A large majority may behave peacefully although continuously challenged by a predatory minority. The rebel-ridden economy either stagnates or grows at a low rate. Growth is decreasing in the size of the predatory minority and its conflict intensity. A final part extends the analysis towards behavior of non-benevolent social elites.

Keywords: Social Conflict, Social Fractionalization, Property Rights, Stagnation, Growth

JEL Classification: C73, D74, O11

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1. Introduction

This paper takes a simple growth model and investigates how social composition affects economic growth when property rights are unenforceable. It explores in a unifying framework two channels through which the subdivision of a society affects growth: social tension and social conflict.[1]

Social tension occurs because people feel the threat of being expropriated. Under the continuing threat of expropriation the economy's capital stock has the properties of a common pool resource. In a symmetric common pool equilibrium everyone – irrespective of social affiliation – invests and consumes identical magnitudes. Simultaneously, the situation is peaceful in the sense that nobody spends time in an appropriation contest. As a consequence everyone consumes according to the fruits of his own investment. Ex post the outcome is compatible with the notion that property rights are respected. These rights, however, are regarded as insecure (not protected by a corrupt or weak government, for example) so that people feel the continuing threat of being expropriated. Although the threat is not executed, its existence is sufficient to explain low investment and growth.

Social Conflict describes a situation where the threat of expropriation is actually executed and people spend part of their time in an appropriation contest. The appropriated shares are determined by a contest success function which is adopted from the literature of rational conflict (Hirshleifer, 1988). Following the conflict literature the appropriative activity is called fighting. This violent interpretation, however, is not explicitly modelled. Appropriation could in principle be of many kinds of violent or non- violent behavior such as fraud, embezzlement, extortion, robbery, exploitation, looting, or war. The crucial feature is that the time devoted to appropriation cannot be used for production of goods.

In order to investigate the conditions for social tension and conflict and their impact on economic development we consider a society divided into several groups. Possible intra-group conflict is assumed to be completely resolved so that members of a group cooperate with each

[1]For the effect of missing property rights or, more generally, bad institutions on economic growth see Keefer and Knack (1995, 1997), Mauro (1995), and Hall and Jones, (1999). For the impact of property rights on investment see e.g. Svensson (1998), and Johnson et al. (2002). Acemoglu et al. (2001), Rodrik et al. (2002), and Easterly and Levine (2003) find evidence for an indirect effect of geographic location on growth through institutional choice at colonial times. The implied fact that good institutions are not rapidly created or destroyed may help to justify the present paper's simplifying assumption of taking the unenforceability of property rights as given.

other and compete with members of other groups. Social groups may differ in number and size. To keep the analysis tractable the paper investigates both criteria separately. The first part considers a varying number of equally sized groups while the second part investigates the behavior of two groups of unequal size.

For theoretical analysis we need not determine how people are allocated to groups. For example, regional clusters, political opinions, language, ethnicity, or religion could be used as allocation device. Studies by Easterly and Levine (1997) and Alesina et al. (2003) find that in particular ethnic fractionalization is negatively correlated with the level and growth rate of per capita income. The present paper provides theoretical support and explanation for their findings.

In contrast to the majority of conflict literature the contest success function used in this paper explicitly allows for peace as an equilibrium outcome so that it can be investigated which conditions trigger and amplify unpeaceful behavior. Before engaging in conflict, members of social groups calculate the opportunity costs through loss of output that their unpeaceful behavior may cause. One of the main results is that conflict prevents growth in symmetric equilibrium. Nobody invests if every social group devotes at least some time to an appropriation contest. For the asymmetric society an equilibrium exists where the majority is peaceful and possibly investing while the minority is not investing and unpeaceful.

The current model differs from most of the literature on rational conflict since it is dynamic. The dynamic formulation allows to investigate repeated social interaction, investment, and economic growth. Related dynamic models of conflict are provided by Grossman and Kim (1996), McDermott (1997), and Garfinkel (1992). Grossman and Kim consider investment behavior of two dynasties where one (the predator dynasty) is allowed to appropriate output of the other (the prey dynasty). McDermott generalizes this approach by endogenizing the choice of being predator or prey.[2] Like the present paper Garfinkel analyzes conflict as a dynamic game of infinite duration. Capital accumulation and growth, however, are not considered. In Section 3 the model of Lane and Tornell (1996) reappears as a special case of peaceful behavior in a symmetric society. A complementary approach to missing property rights is presented by Benhabib and Rustichini (1996). They investigate how two groups develop trigger strategies that help them

[2]The Grossman and Kim approach has been developed further to multiple groups (Gonzales, 2005) and applied to Africa's "conflict diamonds" (Olsson, 2003).

to enforce the first best or a pareto-optimal second best solution. The main difference to the existing literature, however, is the current paper's focus on the key role of social composition in explaining conflict and economic (non-) development.

The remainder of the paper is organized as follows. The next section sets up a dynamic model of conflict for a society of groups of equal size. Section 3 shows that peace is essential for economic growth and explores properties of the balanced growth path. In Section 4 derives conditions for conflict and investigates how appropriation opportunities and social fractionalization affect its intensity. In Section 5 group number is reduced to two and different group size is introduced. It is shown that the no-peace- no-growth result remains valid as long as both groups decide to engage in an appropriation contest. Conditions for growth and civil conflict in an asymmetric society are investigated in Section 6. Section 7 discusses equilibria where the majority of a society behaves peacefully and is challenged by a predatory minority. It is shown that growth (if it exists at all) is decreasing in conflict intensity and how a Matthew-effect can explain why lower productivity may cause higher intensity of conflict. In Section 8, groups are allowed to possess different inherent social power. Equilibria of predatory social elites and mass resistance are investigated. Section 9 concludes by mentioning possible extensions for future research.

2. Investment and Appropriation in a Symmetric Society

Consider an economy populated by $n \geq 2$ groups of equal size. Total population is normalized to one to facilitate comparison with the standard growth model. Hence, each group i, $i = 1, 2, \ldots, n$, consists of a continuum $[0, 1/n]$ of persons. Conflict within groups has been completely resolved so that each group acts as one man. Everyone is endowed with one unit of time that can be spend on production and appropriation. Let τ_i denote the time that a member of group i devotes to appropriation, $0 \leq \tau_i \leq 1$. Noting the qualification made in the introduction, we call the appropriative activity fighting, a group that decides not to appropriate (τ_i=0) peaceful, and a society that consists exclusively of peaceful groups a peaceful society.

Economy-wide capital stock is denoted by k and disposable capital of group i by k_i. As common in the conflict literature, a group's share of capital depends on its effort on appropriation relative to total appropriation activity of all contestants.

$$\frac{k_i}{k} = \frac{\alpha + \tau_i}{n\alpha + \sum_{j=1}^{n} \tau_j}, \quad \alpha > 0 \ . \tag{1}$$

The positive parameter α distinguishes the appropriation contest from most of the conflict literature. Without α, a non-fighting group would receive nothing if one or more other groups are fighting. In other words, in an equilibrium of peace any group could appropriate the entire capital stock by an infinitesimal small fighting activity. This feature would make long-run peace unstable. A positive α avoids that social conflict is already imposed by assumption and allows to derive conditions for peace and conflict as equilibrium outcomes.[3]

For given behavior of the competitors each group's marginal return on fighting is decreasing in α. Thus, the lower α the higher the share that a group can appropriate with a certain fighting effort. In a peaceful society ($\tau_i = 0$ for all i), however, capital is equally distributed among groups and – because of group symmetry – among individuals. Thus, in a symmetric equilibrium of social peace everyone invests and appropriates the same. Because there are simultaneously no income losses through fighting one can say that everyone earns the fruits of his investment. *Ex post* property rights turn out to be respected although their (ex ante) unenforceability exerts a continuous threat on current and future investments.

The magnitude of the appropriability parameter characterizes over what kind of capital or resources a society is competing. A high value of α models contest over hardly appropriable resources as, for example, human capital. A low value, on the other hand, indicates comparatively easily appropriated resources as, for example, arable land, cattle, forests, or drugs.

Capital is used together with working time to produce output using a function $f(\tau_i, k_i) = (1-\tau_i)Ak_i$. In peace, a group produces Ak_i units of output. In conflict a group produces Ak_i units of output in every unit of time that their members do not devote to fighting. Output can be used for consumption or investment. Let per capita consumption and investment be denoted by c_i and e_i. Group i consumes c_i/n units of output and invests e_i/n units. Its budget constraint reads

$$(1-\tau_i)Ak_i = (c_i + e_i)/n \ . \tag{2}$$

Insert (1) into (2) to see that in a peaceful society ($\tau_i = 0$ for all i) every group produces the same income Ak/n and everyone receives an income Ak, which can be used for consumption

[3]Most of the results can be also obtained using a general contest success function of the form $k_i/k = \alpha + \tau_i^m/(n\alpha + \sum_{j=1}^n \tau_j^m)^{-1}$, where m denotes the decisive parameter (Hirshleifer, 1995). Here we focus on the case $m = 1$ in order to avoid unnecessary complexity. The only deviation in results for the general case is mentioned below. Another way to rationalize the parameter α is that it measures a headstart advantage of investors in a contest with appropriators (Konrad, 2002).

and investment. So far the peaceful economy is equivalent to the textbook Ak growth model. Yet, property rights are not secure and the fruits of investment are possibly appropriated by another group. All that is a priori known about investment is that it enlarges the economy-wide available capital stock.

$$\dot{k} = \sum_{i=1}^{n} e_i/n \ . \tag{3}$$

Groups determine consumption and fighting activity in order to maximize intertemporal utility from consumption of their representative member according to $\int_0^\infty U(c_i)\mathrm{e}^{-\rho t}\mathrm{d}t$, where $\rho > 0$ denotes the time preference rate. Instantaneous utility is of the iso-elastic form, $U(c_i) = (c_i^{1-\theta} - 1)/(1-\theta)$. The analysis focuses on the case where $\theta \geq 1$, which is, however, not a restrictive assumption given the empirical evidence on the magnitude of the intertemporal elasticity of substitution (see e.g. Hall, 1988, Ogaki et al., 1996) .

Taking constraints (1) – (3) and a non-negativity constraint for investment, $e_i \geq 0$, into account, the optimization problem for group i, $i = 1, \ldots, n$, reads

$$\max_{\tau_i, c_i} L_i = \frac{c_i^{1-\theta} - 1}{1-\theta} + \lambda_i \left\{ (1-\tau_i) \frac{\alpha + \tau_i}{\alpha n + \sum_{j=1}^n \tau_j} Ak + \sum_{j=1, j\neq i}^{n} (1-\tau_j) \frac{\alpha + \tau_j}{\alpha n + \sum_{h=1}^n \tau_h} Ak - \sum_{j=1}^{n} \frac{c_i}{n} \right\}$$
$$+ \mu_i \left[(1-\tau_i) \frac{\alpha + \tau_i}{\alpha n + \sum_{j=1}^n \tau_j} Ak - \frac{c_i}{n} \right] \ . \tag{4}$$

Group i's shadow price of aggregate capital is denoted by λ_i, and μ_i is a complementary slack variable that assumes the value of zero if investment of group i is strictly positive.

Consider now the conditions for positive investment, i.e. when $e_i > 0$ and $\mu_i = 0$. We have the usual first order condition for consumption

$$c_i^{-\theta} = \lambda_i \ . \tag{5}$$

Taking into account that fighting time must be non-negative, the first order condition for fighting is $(\partial L/\partial \tau_i)\tau_i = 0$ and $\partial L/\partial \tau_i \leq 0$ with

$$\frac{\partial L_i}{\partial \tau_i} = \frac{\lambda_i Ak}{(\alpha n + \sum_{j=1}^n \tau_j)^2} \left\{ (1-\tau_i)\left(\alpha n + \sum_{j=1}^{n} \tau_j\right) - (\alpha + \tau_i)\left(\alpha n + \sum_{j=1}^{n} \tau_j\right) \right. \tag{6}$$
$$\left. -(1-\tau_i)(\alpha+\tau_i) - \sum_{j=1, j\neq i}^{n} (1-\tau_j)(\alpha+\tau_j) \right\} \ .$$

Since individuals are identical (except for social affiliation) and groups are of equal size, symmetry applies. Setting $\tau_i = \tau_j$, for all i, j, (6) becomes

$$\frac{\partial L_i}{\partial \tau_i} = -\lambda_i Ak/n \ . \tag{7}$$

From this we immediately obtain one of the main results.

Theorem 1. *In symmetric equilibrium, economic growth requires a peaceful society.*

Proof. Growth necessarily requires investment, which requires $\mu_i = 0$. Since $c^{-\theta} > 0$ for all $c_i > 0$, $\lambda_i > 0$, and, hence, $\partial L_i / \partial \tau_i < 0$. This in turn requires $\tau_i = 0$ for all groups for the Kuhn-Tucker condition to be fulfilled. □

The result is explained as follows. Positive investment implies that consumption is lower than income. At an interior solution, current consumption depends on the current state of system but not on fighting, $c = c(k(t))$. The only rationale for fighting would be that it improves *future* consumption. Because secure property rights are not available, group i will only enjoy higher future consumption if it's unilateral increase of fighting increases society-wide capital, i.e. if it leads to $\dot{k} > 0$.

The terms following the opening brace in (6) display the different effects of such a unilateral increase of fighting on society-wide investment. Because the investing group i consumes at an interior solution its higher share of appropriated resources is solely used for investment. This positive effect is reflected by the first term in (6). The second and third term capture the negative effect of forgone own production on investment. While the second term measures a direct effect through the time lost in production the third term measures a second-order, indirect effect through the increase of society-wide conflict ($\sum \tau_j$ in the denominator of (1)) that group i's higher fighting activity has caused.

The final term in (6) reflects the negative indirect effect of group i behavior on investment of the other groups. For constant consumption strategy c_j and constant fighting strategy τ_j, of all $j \neq i$, increasing fighting effort of one group i implies less investment of all other groups. Applying symmetry, the third and fourth term exactly compensate the positive first term. Only the second term, the time-loss in production remains. In other words, if investment without secure property rights is worthwhile, then an engagement in social conflict is a waste of time.

The no-peace-no-growth result is fairly general. In particular, it is independent from the specific form of convex utility functions, convex production functions, and contest success functions.[4] It depends, however, crucially on the symmetry assumption. At an interior solution for consumption any gain from fighting would be used for investment in the common pool resource and "next period" the same appropriation problem occurs again. Thus, any investor regards fighting as a time-wasting activity and no group will be simultaneously engage in investment and fighting. Because of symmetry this rationale applies to all groups: the additional investment achieved through fighting replaces exactly the lost investment of all other groups provoked by this expropriative behavior. A society of symmetric groups therefore consists solely of either peaceful investors of violent non-investors. Yet, for societies consisting of asymmetric groups in either size or inherent group power, Theorem 1 cannot be concluded. The second part of this paper therefore investigates whether and how conflict and growth can coexist in asymmetric societies.

3. Peace and Growth without Property Rights

In order to proceed consumption strategies have to be specified. Open-loop strategies require that groups credibly commit to an infinite consumption path. Under the continuing threat of social conflict they are inappropriate.[5] Accordingly, we consider Markovian (or feedback-) strategies $c(k)$ where consumption depends on the current state of the system represented by economy-wide available capital.

For a peaceful society the log-differentiated first order condition for consumption and the costate equation for group i read

$$-\theta\frac{\dot{c}_i}{c_i} = \frac{\dot{\lambda}_i}{\lambda_i} \ , \tag{8}$$

$$\lambda_i\left(A - \sum_{j=1,j\neq i}^{n}\frac{c_j'(k)}{n}\right) = \rho\lambda_i - \dot{\lambda}_i \ . \tag{9}$$

The sum term on the left hand side of (9) shows that groups take strategic interaction into account. It distinguishes the solution from the standard Ak–growth model where property rights are secure. Members of group i (and analogously members of all other groups) know that

[4]This claim is proven in the Appendix.

[5]It is straightforward to show that groups would realize the first best consumption policy if credible commitment were possible. With commitment property rights are quasi secure.

if they invest more and raise the capital stock (k), members of the other groups consume more. Taking these reactions $c_j'(k)$ into account, they compute a more negative growth rate for their group's shadow price of capital (λ_i) and consequently consume more and invest less than with secure property rights. To show this formally, insert (1) and (2) into (3) and apply symmetry. This provides growth of economy-wide capital in a peaceful society as

$$\dot{k} = Ak - c_i \ . \tag{10}$$

Inserting (8) into (9), applying symmetry, using the fact the $c_i'(k) = \dot{c}_i/\dot{k}$, and inserting (10) determines consumption as

$$c_i'(k) = \frac{A - \rho - c_i'(k)(n-1)/n}{\theta\,[Ak - c_i(k)]} \ c_i(k) \ . \tag{11}$$

Use the method of undetermined coefficients to obtain Markovian consumption strategies

$$c_i = \frac{\theta n}{\theta n - (n-1)} \varphi k, \qquad \varphi \equiv A\frac{\theta - 1}{\theta} + \frac{\rho}{\theta} \ , \tag{12}$$

which applies for all groups $i = 1, \ldots, n$. Hence, economy-wide capital, individual consumption, and overall consumption grow at the same rate $g_c \equiv \dot{c}_i/c_i$. Inserting (8) into (9) and substituting c_i' from (12) provides economic growth in a peaceful society without property rights:[6]

$$g_c \equiv \frac{A - n\rho}{\theta n - (n-1)} \ . \tag{13}$$

Now the choice of notation pays off since the results can immediately be compared with results for an Ak–economy with secure property rights. For that purpose refer to the textbook by Barro and Sala-i-Martin (2004, Ch. 4.1, henceforth BS).

Theorem 2. *Consider a linear growth model and a society clustered in symmetric groups. Then individuals in a peaceful society without property rights consume a larger part of output (i.e. invest less) and realize a lower rate of economic growth than individuals in an otherwise identical society with secure property rights.*

[6]For sufficiency it can be verified that the function $V(k) = (\frac{\theta n}{\theta n-(n-1)}\varphi)^{-\theta}/(1-\theta)[k^{1-\theta} - k_0^{1-\theta}] + V(k_0)$ satisfies the Hamilton Jacobi Bellman condition

$$\rho V(k) = \frac{V'(k)^{(\theta-1)/\theta} - 1}{1-\theta} + V'(k)\left[Ak - nV'(k)^{-1/\theta}\right]$$

such that $S(k) = V(k)\mathrm{e}^{-\rho t}$ constitute a value function for group i, $i = 1, \ldots, n$.

Proof. The representative individual in an economy with secure property rights receives the income Ak for sure and consumes c. Solving the optimization problem leads to the consumption strategy $c = \varphi k$ (See BS for details on this part). Since $\theta n > \theta n - (n-1)$, inspection of (12) shows that individuals in a peaceful society without property rights consume a larger part of k and hence of output, Ak. This implies that they invest less.

Inserting consumption under secure property rights into the equation of motion provides the long-run growth rate $(1/\theta)(A - \rho)$ (See BS for details). Since $n \geq 2$, and $\theta \geq 1 > (n-1)/n$, growth without property rights according to (13) is lower.[7] $\square$

Inspection of (13) proves the following result with respect to social fractionalization.

THEOREM 3. *Without property rights the rate of economic growth is decreasing in the number of competing groups.*

With rising group number, individuals are increasingly surrounded by non-cooperative members of competing groups. Because this raises the possibility that the fruits of an investment are appropriated by a competitor, investment and growth are decreasing in the number of competing groups. The finding that increasing social fractionalization slows down economic growth has found empirical support in the studies by Easterly and Levine (1997) and by Alesina et al. (2003). The result implies that a lawless economy performs always worse than a lawful one although anarchy does not necessarily imply social conflict. People may even invest and generate economic growth although property rights are not secure. Positive investment reflects the fact that productivity is sufficiently high so that the opportunity costs of lost production from engaging in conflict exceed the gain from appropriation.

If property rights are secure, people invest when the net interest rate exceeds the time preference rate. In the context of the current model this requires $A > \rho$. If property rights are insecure, this condition is not sufficient. Inspection of (13) shows that investment and growth without property rights require that $A > \rho n$. The number of groups operates as a markup on the capital productivity sufficient for positive investment. The possibility for the condition to hold vanishes with increasing degree of social fractionalization.

[7] Note that A of the current model comprises $(A - \delta)$ in BS and that BS allow for positive population growth (there denoted by n) which is set to zero for comparison with the current model. Furthermore, $A > \rho$, for a meaningful solution with secure property rights, which is assumed to hold throughout this article.

Because individuals are identical except for social affiliation and consume and invest the same quantities, and because nobody engages in appropriation contest, we can ex post conclude that the situation is compatible with the assumption of an existing legal code that has been respected. Property rights, however, are not enforceable. An exogenous fall in productivity (A), for example, could trigger the transition to an equilibrium of non-investment and conflict. The situation can be characterized as being simultaneously peaceful and tense in the sense that people feel the threat of possible expropriation. In times of social tension an economy may grow (although unambiguously at a lower rate than under secure property rights). In times of social conflict, however, growth disappears.

4. Economic Stagnation and Social Conflict

Economic growth requires peace in a symmetric society. Yet, does economic stagnation necessarily provoke conflict? This question is investigated now. The symmetric Nash equilibrium of conflict is particularly easy to analyze. Because nobody invests, groups solve a static problem of consumption maximization. Consumption is obtained from (1) and (2) by setting $e_i = 0$.

$$c_i = (1 - \tau_i) \frac{\alpha + \tau_i}{n\alpha + \sum_{j=i}^{n} \tau_j} Ak \ . \tag{14}$$

The first order conditions w.r.t. τ_i require

$$[(1 - \tau_i) - (\alpha + \tau_i)] \left(n\alpha + \sum_{j=i}^{n} \tau_j \right) - (1 - \tau_i)(\alpha + \tau_i) = 0$$

Apply symmetry to obtain equilibrium fighting efforts τ^*.

$$\tau_i = \tau^* \equiv \max \left\{ 0, \ \frac{\phi - \alpha}{\phi + 1} \right\}, \qquad \phi \equiv \frac{n-1}{n} \tag{15}$$

for all $i = 1, \ldots, n$. For the symmetric society ϕ is equivalent to the index of social fractionalization. This index provides the probability that two people randomly drawn from the population belong to different social groups, i.e. $\phi = 1 - \sum_{i=1}^{n} (1/n)^2$. Inspection of (15) proves the following result.

Theorem 4. *a) There exists a unique symmetric Nash equilibrium of conflict if* $(\phi - \alpha) > 0$, *i.e. if a society is sufficiently fractionalized and appropriation opportunities are sufficiently large.*

b) At a conflict equilibrium, fighting intensity increases with increasing social fractionalization and increasing opportunities to appropriate (decreasing α).

Economy stagnation does not necessarily simultaneously imply conflict in Nash equilibrium. If appropriation possibilities are sufficiently unfavorable, τ^* assumes the corner solution and we observe a stagnating yet peaceful economy. In other words, the model predicts that those societies are particularly prone to conflict that produce with comparatively easily appropriable resources.[8]

While productivity (A) determines whether an economy stagnates and therewith indirectly whether a society is prone to conflict, the intensity of conflict is independent from productivity. In equilibrium, an increase in productivity will improve production and appropriation possibilities for everyone by the same proportion. Clearly, this result is a consequence of the symmetric society. For an asymmetric society, in which some people can be investors and others fighters, we may expect that a productivity change will have asymmetric consequences and thus affects economic and social performance.

The result that conflict intensity increases with social fractionalization is a special application of a general regularity in non-cooperative game theory. The toughness of competition rises with the number of competitors. In static models of conflict it has been observed among others by Hirshleifer (1995) and Grossman (2001). Against the background of missing property rights it has a straightforward intuition. If a society consists of only few groups, everyone is surrounded by a comparatively large number of cooperating group affiliates. As n rises, he becomes increasingly surrounded by possibly hostile members of other groups with whom he is engaged in appropriative contest. Consequently, he increases fighting and lowers productive activities. The effect that the appropriable share increases with the number of competitors is known from the R&D literature as the *business stealing effect*. It reappears here with the difference that stealing can be taken literally.

[8] The prediction is supported empirically by Collier and Hoeffler (2004). Result A in Theorem 4 is the one (mentioned in footnote 3) that is not robust against generalization. Conflict will always occur in a stagnating economy if the decisiveness parameter (m) is smaller than one in a general contest success function. In this case marginal returns from fighting go to infinity as τ_i approaches zero.

5. Asymmetric Groups

So far, it has been shown that a society in peace is an essential prerequisite for positive development. While this result illustrates the individual rationality of being either investor or appropriator, but never both, it is easily refuted by reality where we frequently observe social conflict and economic growth simultaneously. In this case the respective socio-economies are typically not characterized by a whole nation at war but by a fighting minority (called, for example, rebels, guerilla warriors, mafiosi) and a peaceful majority. Although continually threatened by the aggressive minority and the fact that property rights are not secure, members of the majority may actually invest and propagate economic growth. We would expect such behavior if the felt risk of expropriation is sufficiently low, i.e. if appropriation opportunities or the size of the appropriating group are sufficiently small.

In order to investigate conflict and development in an analytically tractable way we consider a society of two groups of size s and $(1-s)$, $s \in (0,1)$. When s is close to one or close to zero a small minority faces a large majority. For $s = 1/2$ the society consists of two groups of equal size and is equivalent to the symmetric case discussed above. To further facilitate analysis we focus on logarithmic utility.

The contest success functions for the asymmetric society are

$$k_1 = \frac{s(\alpha+\tau_1)}{\alpha + s\tau_1 + (1-s)\tau_2} k, \qquad k_2 = \frac{(1-s)(\alpha+\tau_2)}{\alpha + s\tau_1 + (1-s)\tau_2} k \ . \tag{16}$$

In times of society-wide peaceful behavior ($\tau_1 = \tau_2 = 0$), group 1 gets the share s of resources and group 2 the share $(1-s)$ implying that every person is identically equipped irrespective of its social provenience. As argued above we may interpret this as a situation where ex post everyone has obeyed property laws. Respect of the law, however, is solely founded in everyone's own free will and not institutionally enforced. Consequently, everyone feels the continuing threat of possible expropriation.

Groups maximize intertemporal utility from consumption of their representative member given the production function (2), the state equation (3) and the contest success function (16). Group 1 maximizes

$$L_1 = \log(c_1)$$

$$+\lambda_1\left\{(1-\tau_1)\frac{s(\alpha+\tau_1)}{\alpha+s\tau_1+(1-s)\tau_2}Ak+(1-\tau_2)\frac{(1-s)(\alpha+\tau_2)}{\alpha+s\tau_1+(1-s)\tau_2}Ak-sc_1-(1-s)c_2\right\}$$
$$+\mu_1\left[(1-\tau_1)\frac{s(\alpha+\tau_1)}{\alpha+s\tau_1+(1-s)\tau_2}Ak-sc_1\right]\ ,$$

and group 2 maximizes a similar Hamiltonian L_2. Note that c_1 and c_2 denote per capita consumption so that group 1 (consisting of s members) consumes sc_1 and group 2 consumes $(1-s)c_2$.

We verify first that Theorem 1 does not generalize for the asymmetric society.

Lemma 1. *In an economy with insecure property rights populated by two groups of unequal size nobody irrespective of social provenience is simultaneously investor ($e_i > 0$) and appropriator ($\tau_i > 0$).*

Proof. The first order conditions for fighting are $(\partial L_i/\partial\tau_i)\tau_i = 0$, $\partial L_i/\partial\tau_i < 0$, $i = 1, 2$, with

$$\frac{\partial L_1}{\partial\tau_i}=\frac{Ak}{(\alpha+s\tau_1+(1-s)\tau_2)^2}\left\{\lambda_1\left[(1-\tau_1)s-s(\alpha+\tau_1)\right](\alpha+s\tau_1+(1-s)\tau_2)\right.$$
$$-\lambda_1(1-\tau_1)s^2(\alpha+\tau_1)-\lambda_1(1-\tau_2)s(1-s)(\alpha+\tau_2)+\mu_1\left[(1-\tau_1)s-s(\alpha+\tau_1)\right]$$
$$\left.\times(\alpha+s\tau_1+(1-s)\tau_2)-\lambda_1(1-\tau_1)s^2(\alpha+\tau_1)\ \right\}\ , \tag{17a}$$
$$\frac{\partial L_2}{\partial\tau_2}=\frac{Ak}{(\alpha+s\tau_1+(1-s)\tau_2)^2}\left\{\lambda_2\left[(1-\tau_2)(1-s)-(1-s)(\alpha+\tau_2)\right](\alpha+s\tau_1+(1-s)\tau_2)\right.$$
$$-\lambda_2(1-\tau_2)(1-s)^2(\alpha+\tau_2)-\lambda_2(1-\tau_1)s(1-s)(\alpha+\tau_1)+\mu_2\left[(1-\tau_2)(1-s)-(1-s)(\alpha+\tau_2)\right]$$
$$\left.\times(\alpha+s\tau_1+(1-s)\tau_2)-\lambda_2(1-\tau_2)(1-s)^2(\alpha+\tau_2)\ \right\}\ . \tag{17b}$$

First suppose that both groups invest and appropriate so that $\tau_i, e_i > 0$ and $\mu_i = \partial L_i/\partial\tau_i = 0$ for both groups. The only solution of (17) is $\tau_1 = \tau_2 = -a$, contradicting the initial supposition of positive fighting activity.

Now, suppose qualitatively distinct behavior. Without loss of generality let group 1 be peaceful ($\tau_1 = 0$). Suppose that group 2 is simultaneously investing and fighting ($\tau_2 > 0$). Setting $\partial L_2/\partial\tau_2 = \mu_2 = \tau_1 = 0$ in (17b) provides $\tau_2 = -a/(1+\sqrt{s})$ and $\tau_2 = -a/(1-\sqrt{s})$. Because $0 < s < 1$, the solution candidates violate the initial supposition that fighting is positive. □

The no-peace-no-growth result, however, does not carry over. Lemma 1 leaves open a special case of asymmetric behavior according to which a peaceful group invests and another aggressive, non-investing group appropriates. Because a peaceful society has been defined as *mutual* peaceful behavior of all social groups, Theorem 1 does not generalize. The qualification for an asymmetric society that is supported by Lemma 1 reads as follows.

Theorem 5. *In a society of two groups of unequal size, society-wide conflict ($\tau_i > 0$ for all i) prevents economic growth.*

6. Growth and Civil Conflict in an Asymmetric Society

In this section we consider qualitatively similar behavior of both groups. We begin by investigating conditions for society-wide investment.[9]

Theorem 6. *Consider a society without secure property rights consisting of two groups of unequal size. If both groups consist of peaceful investors, everyone's consumption grows at rate*

$$g_c = A - 2\rho \tag{18}$$

irrespective of social affiliation. Members of the larger group, however, invest more than members of the minority.

Proof. Without fighting, the equation of motion for economy-wide capital resulting from (1) and (2) is

$$\dot{k} = Ak - sc_1 - (1-s)c_2 \quad . \tag{19}$$

Positive investment implies $\mu_i = 0$ for $i = 1, 2$. The first order condition for consumption of group 1 is $1/c_1 - s\lambda_1 = 0$ and its costate equation (given that groups follow time-consistent Markovian consumption strategies) is $\lambda_1[A - (1-s)c_2'(k)] = \lambda_1\rho - \dot{\lambda}_1$. Differentiating the first order condition with respect to time, using the results to eliminate λ_1 and $\dot{\lambda}_1$ in the costate equation, using the fact that $c_i'(k) = \dot{c}_i/\dot{k}$, and inserting the equation of motion for capital we obtain

$$c_1'(k) = \frac{\left[A - \rho - (1-s)c_2'(k)\right] c_1(k)}{Ak - sc_1(k) - (1-s)c_2(k)} \quad . \tag{20a}$$

[9] We focus on Nash equilibria. Note, however, that the Markovian Stackelberg solution coincides with the Markovian Nash solution because the strategy of a group depends on strategies of other groups only through the state of the system.

Analogously, we obtain for group 2

$$c_2'(k) = \frac{[A - \rho - sc_1'(k)]\, c_2(k)}{Ak - sc_1(k) - (1-s)c_2(k)} \ . \tag{20b}$$

The solution for equilibrium consumption strategies is

$$sc_1 = (1-s)c_2 = \rho k \ . \tag{21}$$

Both groups consume the same quantity, which is shared by s and $(1-s)$ members, respectively. This implies that members of the larger group consume less and invest more at any given level of k. Resubstituting c_i and c_i' into the costate equation provides the growth rate (18). □

The intuitive explanation for this result is as follows. Members of a small group are surrounded by a large number of non-cooperating individuals. Because property rights are not secure, they feel a high threat of expropriation, i.e. they know that large parts of the fruits of an additional investments would be consumed by members of the hostile large group. In response, they invest comparatively little. Likewise, members of a large group are predominantly surrounded by cooperating group affiliates. They feel a comparatively small risk of expropriation and invest more.

From (21) follows that economy-wide consumption $sc_1 + (1-s)c_2$ is independent from s. Because consumption grows independently from s, a country's social composition does not affect the aggregate performance of an economy *given* that both social groups decide to live in peace. Irrespective of the size of minority and majority, however, economic growth is affected by a lack of property rights. To see this, recall from Section 3 that the economy grows at rate $A-\rho$ when property rights are secure.

Civil conflict describes a situation were all social groups engage in conflict. We know already that nobody invests and the economy stagnates in such situation. The static problem is equivalent to maximizing current consumption. The first order conditions for fighting read

$$0 = (1-\tau_1)\left[1 - \frac{s(\alpha+\tau_1)}{\alpha + s\tau_1 + (1-s)\tau_2}\right] - (\alpha+\tau_1) = F(\tau_1, \tau_2, \alpha, s) \ , \tag{22a}$$

$$0 = (1-\tau_2)\left[1 - \frac{(1-s)(\alpha+\tau_2)}{\alpha + s\tau_1 + (1-s)\tau_2}\right] - (\alpha+\tau_2) = G(\tau_1, \tau_2, \alpha, s) \ . \tag{22b}$$

The explicit solution of (22) is a bulky expression and hard to assess analytically. Using the implicit function theorem, however, we obtain general information about group aggressiveness.

Theorem 7. *At an equilibrium of mutual conflict the intensity of fighting decreases with group size. The minority fights harder.*

This result – proven in the Appendix – is known from the conflict literature as the "Paradox of Power" (Hirshleifer, 1991). A member of a minority is predominantly surrounded by hostile members of the majority. Facing the resulting large possibilities to appropriate, he has a high incentive to engage in conflict. A member of the majority is surrounded predominantly by friendly, cooperating group affiliates and his incentive to engage in conflict is comparatively low. At the end of possible social compositions we have a society subdivided into one person, called a dictator or tyrant, and all other people. The tyrant derives his high incentive for aggressive behavior from the fact that he has nobody with whom he cooperatives.

7. Predatory Minorities and the Matthew Effect

From Theorem 7 we may already infer who will be investor and who will be appropriator if qualitatively distinct social behavior occurs. Indeed, the question has a clear-cut answer (proven in the Appendix).

Theorem 8. *If an economy with insecure property rights is populated by a group of investors and a group of appropriators, then the appropriating group is always a social minority.*

Assume without loss of generality an asymmetric case where group 2 is peaceful and possibly investing. If it indeed invests, we obtain (20b) from the first order condition for consumption, state equation, and costate equation. The solution is (21) implying that group 2 consumes the same share of resources irrespective of the aggressive behavior of group 1. However, group 2 gets a lower share of resources when group 1 is fighting than in mutual peace. Taken together, this implies that the investment rate, e_2/k, is smaller when group 1 is fighting. Because group 1 is not investing, economic growth is solely determined by investment of group 2 and obtained as:

$$g_c = \max\left\{0,\ \frac{\alpha(1-s)A}{\alpha + s\tau_1} - \rho\right\} \quad . \tag{23}$$

Economic growth is decreasing in the size of the fighting minority (s) and its fighting intensity. In other words, a fighting minority ($\tau_1 > 0$) further reduces capital productivity (which would be $(1-s)A$ in a peaceful society and A if, additionally, property rights were secure). If the fighting group is sufficiently large or its fighting sufficiently intense, the majority does not invest even though productivity would be high enough to guarantee investment if property rights were secure (i.e. $A > \rho$ but $\alpha(1-s)A/(a+s\tau_1) < \rho$). Without investment, appropriation opportunities (captured by the magnitude of α) decide whether the majority will then also engage in conflict or whether unilateral conflict prevails.

Determining the equilibrium intensity of unilateral fighting is a little more complicated since the fighting group has to take into account the indirect effect of its aggressive behavior on the state equation i.e. its future appropriation opportunities. Given peaceful behavior of the majority (again assumed to be group 2), optimal fighting intensity fulfills:

$$\begin{aligned} 0 = F(\tau_1, \alpha, A, \rho) &\equiv \alpha(1-\tau_1)(1-s)s(\alpha+\tau_1)(A/\rho) - [(1-\tau_1)-(\alpha+\tau_1)](\alpha+s\tau_1)^2 \\ &+ (1-\tau_1)s(\alpha+\tau_1)(\alpha+s\tau_1) \ . \end{aligned} \tag{24}$$

Equation (24) and the following result are derived in the Appendix.

Theorem 9. *If unilateral conflict exists, then its intensity is decreasing in productivity (A) and increasing in impatience (ρ).*

Unilateral conflict differs qualitatively from mutual conflict. Now, productivity has an impact on social conflict because it affects investors and appropriators differently. Conflict is especially intense in societies that populate an economy with low productivity. Intuitively, the result is explained as follows. The appropriating minority takes into account the negative feedback effect that their behavior may have on investment of the peaceful group and therewith on their own future consumption. A fall of productivity lowers growth and future appropriation possibilities and increases the incentive to appropriate now. Inspection of (24) shows that it is impatience adjusted productivity (A/ρ) that matters for conflict. The possibility of conflict is in particular large if the instantaneous appropriation gain receives a large weight in utility maximizing calculus.

Consider two social groups producing on infertile land. From the viewpoint of a possible predator it can be rational to expropriate the meagre harvest of his poor neighbor because not much would be left after consumption anyway, and the loss of investment, growth, and future appropriation possibilities induced by social conflict is small. If the groups produce on fertile land, however, it may be rational not to expropriate the rich neighbor. The loss of growth through conflict induced by its negative impact on investment may overcompensate the appropriation gain. In sociology it is sometimes referred to a situation in which benefits and harms accrue disproportionally to rich and poor as a *Matthew effect* in an allusion to a verse in the gospel: "For whoever has, to him shall be given and he shall have more abundance; but whoever has not, from him shall be taken away even that he has."(Bible, Matthew 13:12). The result of Theorem 9 rationalizes a literally-taken Matthew effect. It is supported by empirical work by Rodrik (1999) who observes that the poor growth performance of many less developed countries in the 1970s is not only explained by negative productivity shocks (terms of trade) but also by social conflict that these productivity shocks may have induced.

Finally, some numerical calculations illustrate the determinants of conflict and growth without property rights. Table 1 shows results for three different economies populated by four different societies. We consider a very small minority ($s = 0.01$), a ten percent minority ($s = 0.1$), a large minority ($s = 1/3$), and two groups of equal size ($s = 1/2$). Time preference, ρ, is set to 0.02 in all examples. General productivity of the first economy, displayed on the left, is 0.035, implying that this economy would grow at a rate of 1.5 percent if property rights were secure. Appropriation opportunities, however, are relatively large, as indicated by the low value of α of 0.05. Under these circumstances a small social minority (the rebels) spend 41 percent of their time appropriating wealth from the large majority. Although the minority is very aggressive it generates only little threat of expropriation because it is simultaneously of small social importance (measured by its relative size). The majority behaves peacefully and invests. The economy grows at a rate of 1.2 percent, 0.3 percentage points lower than it would grow if property rights were secure. Qualitatively the result does not change when the aggressive minority grows to 10 percent of population ($s = 0.1$). The majority behaves still peaceful and invests. The felt threat of expropriation, however, is substantially higher, investment is low, and the economy grows at a meagre rate of 0.33 percent.

TABLE 1: PRODUCTIVITY, APPROPRIATION OPPORTUNITY, AND CONFLICT INTENSITY

	$A = 0.035, \alpha = 0.05$				$A = 0.045, \alpha = 0.05$				$A = 0.035, \alpha = 0.5$			
s	0.01	0.1	1/3	1/2	0.01	0.1	1/3	1/2	0.01	0.1	1/3	1/2
τ_1	0.41	0.18	0.32	0.30	0.40	0.14	0.02	0	0.20	0.11	0	0
τ_2	0	0	0.18	0.30	0	0	0	0	0	0	0	0
e_1/k	0	0	0	0	0	0	0	0.25	0	0	0	0
e_2/k	1.20	0.33	0	0	2.13	1.14	0.72	0.25	1.50	1.08	0.33	0
Δg_c	0.30	1.17	1.50	1.50	0.38	1.35	1.78	2.00	0.05	0.42	1.17	1.50

$\rho = 0.02$. The last row, Δg_c, shows the loss of growth against an identical economy with secure property rights. Investment rates and loss of growth are displayed in percentage points.

The picture changes qualitatively when the minority is of significant size ($s = 1/3$). In this case the felt threat of appropriation is sufficiently high so that both groups engage in appropriation contest. The business stealing effect (or the Paradox of Power) operates and the minority fights harder. Conflict intensity is highest when the country is populated by a highly polarized society of two equally sized groups. In that case everyone devotes 30 percent of his time to appropriate resources. A massive time-loss in production results. Moreover, in mutual conflict nobody invests, the economy stagnates, and the loss of growth is largest.

The middle panel in Table 1 considers societies in an economy of higher overall productivity ($A = 0.045$, potential growth rate 2.5 percent). In this case, and given that both groups are of significant size, the cost of lost production and foregone growth opportunities implied by an engagement in conflict results in society-wide peace. The peaceful situation, however, is simultaneously tense. Everyone feels the threat of possible expropriation. For a member of a 1/3–minority this threat is high enough to prevent any investment. For a highly polarized society ($s = 0.5$) both groups invest albeit at a low rate. The economy grows at a rate of 0.5 percent, two percent less than it could grow with secure property rights. On the other hand, the calculation also reveals that higher productivity does not improve performance of the rebel-ridden society ($s = 0.01$) by much. For $s = 0.1$ we observe the Matthew effect. A fall in productivity (reading the table from the middle to the left) causes increasing conflict activity and further decreasing investment.

The right panel shows results when the economy's resource is harder to appropriate ($\alpha = 0.5$) reflecting, for example, a capital stock that consists to a lesser extent of natural resources. As in the case of increasing productivity, engaging in conflict is no longer worthwhile when both groups are of significant size. Investment, however, remains low or absent because groups still feel the risk of expropriation.

8. Non-Benevolent Social Elites and Mass Resistance

So far we have assumed that groups are identical in their inherent appropriative power. They share contest success functions in which any asymmetry resulted from different group size only. While this assumption is useful to isolate impacts of social composition on group behavior and economic performance, it abstracts from the fact that frequently one group enjoys inherently larger social power. We can think of a state representing the interests of this group's members. Of course, such a state does not portray a Hobbesian Leviathan or any other form of benevolent government. It is a non-benevolent, appropriative, and possibly violent state. At the extreme the state is a monopoly of violence used to appropriate wealth of its citizens, the other, powerless group of society.

Let $s < 1/2$, and let the smaller group be equipped with larger inherent power reflected by the following contest success functions.

$$\frac{k_1}{k} = (1-\tau_1)\frac{s(\alpha+\tau_1)}{\alpha+s\tau_1+(1-s)\lambda\tau_2}, \quad \frac{k_2}{k} = (1-\tau_2)\frac{(1-s)(\alpha+\lambda\tau_2)}{\alpha+s\tau_1+(1-s)\lambda\tau_2}, \quad \lambda \in [0,1] \ . \tag{25}$$

The new parameter λ measures relative appropriative success of group 2, the society's majority. For $\lambda = 1$, the model reduces to the one of the previous sections where groups possess identical inherent power. With decreasing λ the majority loses power. A given effort in the appropriative activity yields less appropriative returns. At $\lambda = 0$, the majority is powerless in the sense that the time spent on appropriation (or – given the unequal structure of contest – on defending against appropriation) is ineffective. The first group has monopoly power of violence. For small s, we can think of group 1 as an aristocracy, oligarchy, or ruling elite. For $s \to 0$ group 1 converges towards a non-benevolent dictator.[10]

Inspect (25) to verify that the model collapses to the one already discussed in case of mutual peace or peaceful behavior of the majority. The interesting equilibrium is the one of mutual

[10]The present article focusses on impacts of social composition on appropriative state behavior. It does not provide an explanation for why one group has inherently larger power (or state control). One explanation is developed by Acemoglu et al. (2004) in a model of longevity of kleptocratic dictators.

conflict. It could be characterized as mass resistance against a predatory state. Setting $e_i = 0$ (because mutual conflict precludes investment), inserting (25) in (2) and maximizing consumption provides the first order conditions

$$0 = (1-\tau_1)\left[1 - \frac{s(\alpha+\tau_1)}{\alpha+s\tau_1+(1-s)\lambda\tau_2}\right] - (\alpha+\tau_1) = F(\tau_1,\tau_2,\alpha,s,\lambda) \ , \tag{26a}$$

$$0 = (1-\tau_2)\left[1 - \frac{(1-s)(\alpha+\lambda\tau_2)}{\alpha+s\tau_1+(1-s)\lambda\tau_2}\right] - \left\{\frac{\alpha+\tau_2}{\lambda}\right\} = G(\tau_1,\tau_2,\alpha,s,\lambda) \ . \tag{26b}$$

Because the model has not changed in structure with respect to s, Theorem 7 on group size and fighting intensity continues to hold. Additionally, an interesting result with respect to the power of the masses can be derived (proven in the Appendix).

Theorem 10. *Consider a society of an inherently strong minority and a weak majority. If an equilibrium of mutual conflict exists, then increasing power of the majority a) leads unambiguously to increasing violence of the minority, and b) leads to increasing violence of the majority given that it is initially sufficiently weak (λ sufficiently small).*

If the social majority is initially sufficiently weak, a power extension leads to higher absolute returns in contest, implying more defensive success against the appropriative group. Consequently, the majority defends more, and the predatory minority increases appropriation efforts in order to maintain a certain level of consumption. Because both social groups raise their fighting intensities, a corollary of the theorem follows immediately.

Corollary 1. *Increasing power of a weak social majority increases the intensity of society-wide conflict given that the majority is initially sufficiently weak.*

Yet, we cannot rule out analytically that just the opposite may happen. The opposite case requires that a majority is sufficiently strong albeit weaker than the minority. It may then react to increasing power with decreasing conflict. For an intuitive explanation reconsider equation (26b), the net marginal return on fighting for group 2 (measured at the equilibrium and scaled by factor $(\alpha + s\tau_1 + (1-s)\tau_2)/(1-s)\lambda)$. The first term in (26b) reflects the gross marginal return on appropriation. The second term in braces describes the marginal loss in production induced by an additional unit of time devoted to conflict. The derivative w.r.t. λ of the whole expression is

$$\frac{\partial G}{\partial \lambda} = -\frac{(1-s)s(1-\tau_2)(\alpha+\tau_1)\tau_2}{[\alpha+s\tau_1+(1-s)\lambda\tau_2]^2} + \frac{\alpha}{\lambda^2} \ . \tag{27}$$

Increasing power of the masses lowers the time-loss in production because the same amount of resources can be appropriated (or defended against appropriation) with less fighting effort. This effect is captured by the last term in (27). It is the dominating effect if the majority is sufficiently weak (let λ approach zero to see this). For a sufficiently strong majority, however, it cannot be ruled out that the first term overcompensates the second term. The negative first term is another example for the Paradox of Power. Increasing inherent group power (to defend resources) reduces marginal returns in appropriation contest. The group has no longer to spend much effort on defending against appropriation and can shift some time to production instead. With respect to decreasing λ, the result can be put differently. Deprivation of a sufficiently strong majority may lead to mass rebellion.

TABLE 2: Social Power and Conflict

	$\lambda = 1$			$\lambda = 1/3$			$\lambda = 1/5$		
s	0.01	1/3	1/2	0.01	1/3	1/2	0.01	1/3	1/2
τ_1	0.41	0.32	0.30	0.41	0.27	0.24	0.41	0.24	0.21
τ_2	0	0.18	0.30	0	0.24	0.38	0	0.20	0.37

$\rho = 0.02$, $A = 0.035$, $\alpha = 0.05$.

Table 2 illustrates the results numerically. It considers three possible social divisions with alternative power of the second group. The left panel repeats the left panel from Table 1, i.e. $A = 0.035$, $\rho = 0.02$, and $\alpha = 0.05$ and equally strong social groups. In the middle and right panel the second group is weaker. Results remain unchanged in case of $s = 0.01$, i.e. when a small rebel group (or a non-benevolent dictator) receives a further power increase. Given that both groups are of significant size ($s = 1/3, s = 1/2$), however, we observe the above explained non-linear response to a fall of social power. A partial deprivation of an inherently strong group (a fall from $\lambda = 1$ to $\lambda = 1/3$) increases its fighting efforts. Following a further deprivation (from $\lambda = 1/3$ to $\lambda = 1/5$), however, the weak group reduces resistance against appropriation. In other words (reading the table from right to left), a partial empowerment of an initially weak group increases social conflict. Further empowerment of an already sufficiently strong group lowers society-wide conflict.

9. Final Remarks

This article has investigated a linear growth model where the population is divided into non-cooperative groups, and property rights are not enforceable. Besides production and investment people may engage in an appropriative contest over the economy's resources. For a society of symmetric groups it has been shown that positive economic development requires a peaceful society. The result is founded by an individual rationale according to which nobody wants to be simultaneously investor in and appropriator of the same resource. An asymmetric society, however, may consist of a group of investors and another group of appropriators. In that case, the paper has explained why the social minority turns out to be the aggressive appropriator and the majority behaves peacefully and may even invest (albeit at a low rate) if the felt threat of expropriation is sufficiently small. In any case, civil conflict, i.e. appropriative behavior of all social groups, prevents economic development.

If economic growth occurs, it is decreasing in social fractionalization, and countries with easily appropriable natural resources are especially prone to conflict. A Matthew effect can be explained according to which a fall of productivity triggers increasing appropriative conflict which, in turn, further deteriorates economic performance. Thereby, the article offers a theory that can explain some empirical regularities found in recent research about Africa's poor economic and social performance (Collier and Gunning, 1999, Easterly and Levine, 1997).

Nevertheless, the article should be seen as a first attempt to investigate impacts of social composition on economic growth. This paper has deliberately avoided the term *social structure*, leaving it for future analysis of a more sophisticated division of society. Possible extensions may, for example, include measures of polarization (Esteban and Ray, 1994), an endogenous allocation device for group affiliation, intra group sharing rules, and – maybe most importantly – explanations of how social composition may foster or hinder development of institutions.

Appendix

A. General Proof of the no–peace–no–growth result. Let U denote a utility function fulfilling $U' > 0$ and $U'' < 0$, let f be a production function with $f(k_i) > 0$ for $k_i > 0$ otherwise, and let

$$\frac{k_i}{k} = \frac{g(\tau_i)}{\sum_{j=1}^n g(\tau_j)} \quad ,$$

be a general form of the contest success function (1) for the representative group i. A household's time is normalized to one and is devoted to production and fighting. Hence, a group produces

$$y_i = (1-\tau_i) f\left[\frac{g(\tau_i)k}{\sum_{j=1}^n g(\tau_j)}\right] \quad .$$

The first order condition for an interior solution of consumption (implying positive investment) is $U'(c_i) = \lambda_i$ so that $\lambda_i > 0$. At an interior solution for investment the first order condition for fighting – which cannot be negative – is $(\partial L/\partial \tau_i)\tau_i = 0$ and $\partial L/\partial \tau_i \leq 0$ with

$$\frac{\partial L_i}{\partial \tau_i} = \lambda_i \left\{ (1-\tau_i)\frac{g'(\tau_i) f'[\cdot]k}{\sum_{j=1}^n g(\tau_j)} - f[\cdot] - \sum_{j=1}^n (1-\tau_j) \frac{g(\tau_i)g'(\tau_j)f'[\cdot]k}{\left[\sum_{j=1}^n g(\tau_j)\right]^2} \right\} \quad .$$

Applying symmetry the right hand side simplifies to $-\lambda_i f[\cdot]$, a negative expression. The Kuhn-Tucker condition requires $\tau_i = 0$.

B. Proof of of Theorem 7. Partial derivatives of (22) are

$$\begin{aligned}
\frac{\partial F}{\partial \tau_1} &= -\left\{(1-s)(\alpha+\tau_2)\left[\alpha + s + (1-s)\tau_2\right]\right\}/N^2 - 1 < 0 \\
\frac{\partial F}{\partial \tau_2} &= \left\{(1-s)(\alpha+\tau_1)s(1-\tau_1)\right\}/N^2 > 0 \\
\frac{\partial G}{\partial \tau_1} &= \left\{(1-s)(\alpha+\tau_2)s(1-\tau_2)\right\}/N^2 > 0 \\
\frac{\partial G}{\partial \tau_2} &= -\left\{s(\alpha+\tau_1)\left[\alpha + (1-s) + s\tau_1\right]\right\}/N^2 - 1 < 0 \\
\frac{\partial F}{\partial s} &= -\left\{(1-\tau_1)(\alpha+\tau_1)(\alpha+\tau_2)\right\}/N^2 < 0 \\
\frac{\partial G}{\partial s} &= \left\{(1-\tau_2)(\alpha+\tau_1)(\alpha+\tau_2)\right\}/N^2 > 0, \qquad \text{where } N \equiv \alpha + s\tau_1 + (1-s)\tau_2 \ .
\end{aligned}$$

Without loss of generality we consider fighting intensity of group 1. Using the implicit function theorem and Cramer's rule

$$\frac{\partial \tau_1}{\partial s} = \frac{\det J_1}{\det J}, \quad \det J = \frac{\partial F}{\partial \tau_1}\frac{\partial G}{\partial \tau_2} - \frac{\partial F}{\partial \tau_2}\frac{\partial G}{\partial \tau_1}, \quad \det J_1 = -\frac{\partial F}{\partial s}\frac{\partial G}{\partial \tau_2} + \frac{\partial F}{\partial \tau_2}\frac{\partial G}{\partial s} \quad .$$

Because $\tau_2 \geq 0$, $s + (1-s)\tau_2 > s(1-\tau_2)$, and comparing absolute values, $|\partial F/\partial \tau_1| > |\partial G/\partial \tau_1|$. Similarly, one concludes $|\partial G/\partial \tau_2| > |\partial F/\partial \tau_2|$. Hence, the two negative multipliers of the first term in $\det J$ are larger than the two positive multipliers of the second term. Therewith, $\det J > 0$.

$$\det J_1 = \frac{(\alpha+\tau_1)(\alpha+\tau_2)}{N^2} M_1, \quad M_1 \equiv (1-\tau_1)\frac{\partial G}{\partial \tau_2} + (1-\tau_2)\frac{\partial F}{\partial \tau_2} \quad .$$

After some algebra M_1 simplifies to $M_1 = -(1-\tau_1)(\alpha+\tau_1)s/N^3 - (1-\tau_1) < 0$, and therewith $\det J_1 < 0$ and $\partial \tau_1/\partial s < 0$.

C. Proof of Theorem 8. Assume without loss of generality that group 1 is fighting and that group 2 is peaceful. Without fighting, group 1 would get the share s of resources, i.e.

$$(1-\tau_1)\frac{s(\alpha+\tau_1)}{\alpha + s\tau_1} > s \quad \Rightarrow \quad (1-\tau_1)(\alpha+\tau_1) > \alpha + s\tau_1 \qquad \text{(A.1)}$$

for fighting to be worthwhile.

Group 2 produces output

$$(1-s)\frac{\alpha+\tau_2}{\alpha+s\tau_1+(1-s)\tau_2}(1-\tau_2)Ak.$$

The derivative with respect to τ_2 taken at $\tau_2 = 0$ has to be negative for that group 2 has no incentive to deviate from peaceful behavior. This requires

$$(1-\alpha)(\alpha+s\tau_1)-(1-s)\alpha<0. \tag{A.2}$$

Group 1 produces output

$$s\frac{\alpha+\tau_1}{\alpha+s\tau_1+(1-s)\tau_2}(1-\tau_1)Ak.$$

The derivative with respect to τ_1 taken at $\tau_2 = 0$ has to be positive for an incentive for group 1 to fight. This requires

$$(\alpha+s\tau_1)(1-\alpha)>s(\alpha+\tau_1)(1-\tau_1). \tag{A.3}$$

Now combine (A.2) and (A.3):

$$s(\alpha+\tau_1)(1-\tau_1)<(1-s)\alpha \quad\Rightarrow\quad (1-\tau_1)(\alpha+\tau_1)<\alpha(1-s)/s.$$

Use this information in (A.1) to get

$$\alpha+s\tau_1<\alpha(1-s)/s \quad\Rightarrow\quad \alpha<\alpha(1-s)/s \quad\Rightarrow\quad s<1/2.$$

Group 1 has to be of a size smaller than 1/2, i.e. it has to be a minority.

D. Derivation of optimal unilateral conflict [equation (24)]. Let group 1 be a fighting, non-investing minority. Without investment, $\mu_1 > 0$, and the first order condition for consumption requires

$$1/c_1 = s\lambda_1 + s\mu_1 \ . \tag{A.4}$$

Taking dynamic interaction through possible investment of the peaceful group into account, the costate equation reads

$$\lambda_1\left\{(1-\tau_1)\frac{s(\alpha+\tau_1)}{\alpha+s\tau_1}A+\frac{(1-s)\alpha}{\alpha+s\tau_1}A-(1-s)c_2'(k)\right\}+\mu_1(1-\tau_1)\frac{s(\alpha+\tau_1)}{\alpha+s\tau_1}A=\lambda_1\rho-\dot{\lambda}_1 \ . \tag{A.5}$$

With positive fighting of group one the first order condition for fighting requires $\partial L_1/\partial\tau_1 = 0$. Setting $\tau_2 = 0$ we obtain from eq. (17a)

$$\frac{\lambda_1+\mu_1}{\lambda_1}\left\{[(1-\tau_1)-(\alpha+\tau_1)](\alpha+s\tau_1)-(1-\tau_1)s(\alpha+\tau_1)\right\}=(1-s)\alpha \ . \tag{A.6}$$

Suppose a constant solution τ_1 exists. Then, $(\lambda_1+\mu_1)/\lambda_1$ is constant and (dividing by λ_1 and log-differentiating) we conclude $\dot{c}_1/c_1 = \dot{\lambda}_1/\lambda_1$ from (A.4). With fighting being constant the appropriated share is constant and consumption grows at equal rates for both groups.

Replacing $\dot{\lambda}_1/\lambda_1$ with g_c from (23) and inserting $(1-s)c_2' = \rho$ from (21), condition (A.5) becomes

$$\frac{\lambda_1+\mu_1}{\lambda_1}(1-\tau_1)\frac{s(\alpha+\tau_1)}{\alpha+s\tau_1}A=\rho \ . \tag{A.7}$$

Inserting (A.6) in (A.7) provides (24) in the text.

E. Proof of Theorem 9. The derivative of (24) w.r.t. τ_1 is

$$\alpha(1-s)s[(1-\tau_1)-(\alpha+\tau_1)]A/\rho+B, \quad \text{where } B\equiv 2(\alpha+s\tau_1)^2-2s[(1-\tau_1)-(\alpha+\tau_1)](\alpha+s\tau_1)$$
$$+s^2(1-\tau_1)(\alpha+\tau_1)+s(1-\tau_1)+s(1-\tau_1)(\alpha+s(\tau_1)-s^2(\alpha+\tau_1)(\alpha+s\tau_1) \ .$$

Inspection of (24) shows that $[(1-\tau_1)-(\alpha+\tau_1)]>0$ for existence of a positive solution for τ_1. Since $A>\rho$ (otherwise the optimization problem has no positive solution when property rights are secure), it is sufficient to show that

$$\alpha(1-s)s[(1-\tau_1)-(\alpha+\tau_1)]+B$$

is positive for $\partial F/\partial\tau_1>0$. This expression simplifies to

$$\alpha^2(2+s^2)+s\tau_1(4\alpha+2\alpha s+3s\tau_1)>0 \ .$$

Furthermore, $\partial F/\partial(A/\rho)=\alpha(1-\tau_1)(1-s)s(\alpha+\tau_1)>0$. Applying the implicit function theorem shows

$$\frac{\partial\tau_1}{\partial(A/\rho)}=-\frac{[\partial F/\partial(A/\rho)]}{(\partial F/\partial\tau_1)}<0 \ .$$

F. Proof of of Theorem 10. Partial derivatives of (26) are

$$\begin{aligned}
\frac{\partial F}{\partial\tau_1}&=-\left\{(1-s)(\alpha+\lambda\tau_2)\left[\alpha+s+(1-s)\lambda\tau_2\right]\right\}/N^2-1<0\\
\frac{\partial F}{\partial\tau_2}&=\left\{(1-s)(\alpha+\tau_1)s(1-\tau_1)\right\}/N^2>0\\
\frac{\partial G}{\partial\tau_1}&=\left\{(1-s)(\alpha+\lambda\tau_2)s(1-\tau_2)\right\}/N^2>0\\
\frac{\partial G}{\partial\tau_2}&=-\left\{s(\alpha+\tau_1)\left[\alpha+(1-s)\lambda+s\tau_1\right]\right\}/N^2-1<0\\
\frac{\partial F}{\partial\lambda}&=\left\{(1-s)s(1-\tau_1)(\alpha+\tau_1)\tau_2\right\}/N^2>0\\
\frac{\partial G}{\partial\lambda}&=-\left\{(1-s)s(1-\tau_2)(\alpha+\tau_1)\tau_2\right\}/N^2+\frac{\alpha}{\lambda^2}, \qquad \text{where } N\equiv\alpha+s\tau_1+(1-s)\lambda\tau_2 \ .
\end{aligned}$$

We first consider fighting intensity of group 1. Using the implicit function theorem and Cramer's rule

$$\frac{\partial\tau_1}{\partial\lambda}=\frac{\det J_{1,\lambda}}{\det J}, \quad \det J=\frac{\partial F}{\partial\tau_1}\frac{\partial G}{\partial\tau_2}-\frac{\partial F}{\partial\tau_2}\frac{\partial G}{\partial\tau_1}, \quad \det J_{1,\lambda}=-\frac{\partial F}{\partial\lambda}\frac{\partial G}{\partial\tau_2}+\frac{\partial F}{\partial\tau_2}\frac{\partial G}{\partial\lambda} \ .$$

From the proof of Theorem 7 we use $\det J>0$.

$$\det J_{1,\lambda}=-\frac{(1-s)s(\alpha+\tau_1)\tau_2}{N^2}M_2+\frac{\alpha}{\lambda^2}\frac{\partial F}{\partial\tau_2}, \quad M_2\equiv(1-\tau_1)\frac{\partial G}{\partial\tau_2}+(1-\tau_2)\frac{\partial F}{\partial\tau_2} \ .$$

Because $\partial F/\partial\tau_2>0$, it is sufficient to show that $M_2<0$ to prove positivity of $\det J_{1,\lambda}$.

After some algebra M_2 simplifies to $M_2=-(1-\tau_1)(\alpha+\tau_1)s/N^3-(1-\tau_1)<0$, and therewith $\det J_{1,\lambda}1<0$ and $\partial\tau_1/\partial\lambda>0$.

Similarly,

$$\frac{\partial\tau_1}{\partial\lambda}=\frac{\det J_{2,\lambda}}{\det J}, \quad \det J_{2,\lambda}=-\frac{\partial F}{\partial\tau_1}\frac{\partial G}{\partial\lambda}+\frac{\partial F}{\partial\lambda}\frac{\partial G}{\tau_1} \ ,$$

and

$$\det J_{2,\lambda}=\frac{(1-s)s(\alpha+\tau_1)\tau_2}{N^2}M_3-\frac{\alpha}{\lambda^2}\frac{\partial F}{\partial\tau_1}, \quad M_3\equiv(1-\tau_1)\frac{\partial G}{\partial\tau_1}+(1-\tau_2)\frac{\partial F}{\partial\tau_1} \ .$$

M_3 simplifies to $-(1-\tau_2)(1-s)(\alpha+\lambda\tau_2)/N^3<0$. Hence, the whole first term is negative. The second term, $-(\alpha/\lambda^2)(\partial F/\partial\tau_1)$ is, however, positive. Moreover, for $\lambda\to 0$ the second term approaches infinity while the first term approaches a finite value. The second term, therefore, dominates for sufficiently small λ implying $\partial\tau_2/\partial\lambda>0$.

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